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## **Does subacromial injection of a local anesthetic influence strength in healthy shoulders?: a double-blinded, placebo-controlled study**

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**Abstract:** **BACKGROUND:** Subacromial injection of a local anesthetic is used to eliminate pain as a confounding factor in clinical assessment of abduction strength in shoulders with a suspected rotator cuff tear. If strength remains diminished despite pain relief, a rotator cuff tear is likely. The effect of injecting local anesthetic into the subacromial space on the strength of a normal shoulder is unknown, although it could affect strength by impairing suprascapular or axillary nerve function. We hypothesized that subacromial injection of a local anesthetic could decrease shoulder abduction and/or external rotation strength, resulting in physical examination findings that could mislead the clinician. **METHODS:** A double-blinded, randomized, placebo-controlled design was used to evaluate the effect of subacromial injection of lidocaine on shoulder strength in ten healthy male volunteers. The contralateral shoulder served as the placebo control for each treated shoulder. Abduction and external rotation strength measurements and electromyographic assessment were performed before and after the subacromial injection. Ultrasonography was used to verify the integrity of the rotator cuff and to document the distribution pattern of the injected local anesthetic. **RESULTS:** The injection was subacromial in eighteen (90%) of twenty shoulders. There was no significant difference in pain or electromyographic parameters between shoulders injected with lidocaine and those injected with 0.9% saline solution ( $p > 0.05$ ). In the Whipple position, placebo injection into the subacromial space decreased strength significantly compared with the pre-injection state ( $95 \pm 17$  to  $84 \pm 20$  N,  $p = 0.012$ ), whereas a similar decrease observed in the lidocaine group did not reach significance ( $97 \pm 15$  to  $87 \pm 14$  N,  $p = 0.092$ ). In  $90^\circ$  of abduction in the scapular plane (supraspinatus test position), there was no significant decrease in strength in either group. **CONCLUSIONS:** Subacromial injection reached the subacromial bursa in most cases (90%) without radiographic guidance. The injection of a local anesthetic into the subacromial bursa had no relevant effect on shoulder strength and did not falsify the clinical assessment of strength. **LEVEL OF EVIDENCE:** Diagnostic Level I. See Instructions for Authors for a complete description of levels of evidence.

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# Does Subacromial Injection of a Local Anesthetic Influence Strength in Healthy Shoulders?

## A Double-Blinded, Placebo-Controlled Study

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*Investigation performed at Balgrist University Hospital, Zürich, Switzerland*

**Background:** Subacromial injection of a local anesthetic is used to eliminate pain as a confounding factor in clinical assessment of abduction strength in shoulders with a suspected rotator cuff tear. If strength remains diminished despite pain relief, a rotator cuff tear is likely. The effect of injecting local anesthetic into the subacromial space on the strength of a normal shoulder is unknown, although it could affect strength by impairing suprascapular or axillary nerve function. We hypothesized that subacromial injection of a local anesthetic could decrease shoulder abduction and/or external rotation strength, resulting in physical examination findings that could mislead the clinician.

**Methods:** A double-blinded, randomized, placebo-controlled design was used to evaluate the effect of subacromial injection of lidocaine on shoulder strength in ten healthy male volunteers. The contralateral shoulder served as the placebo control for each treated shoulder. Abduction and external rotation strength measurements and electromyographic assessment were performed before and after the subacromial injection. Ultrasonography was used to verify the integrity of the rotator cuff and to document the distribution pattern of the injected local anesthetic.

**Results:** The injection was subacromial in eighteen (90%) of twenty shoulders. There was no significant difference in pain or electromyographic parameters between shoulders injected with lidocaine and those injected with 0.9% saline solution ( $p > 0.05$ ). In the Whipple position, placebo injection into the subacromial space decreased strength significantly compared with the pre-injection state ( $95 \pm 17$  to  $84 \pm 20$  N,  $p = 0.012$ ), whereas a similar decrease observed in the lidocaine group did not reach significance ( $97 \pm 15$  to  $87 \pm 14$  N,  $p = 0.092$ ). In  $90^\circ$  of abduction in the scapular plane (supraspinatus test position), there was no significant decrease in strength in either group.

**Conclusions:** Subacromial injection reached the subacromial bursa in most cases (90%) without radiographic guidance. The injection of a local anesthetic into the subacromial bursa had no relevant effect on shoulder strength and did not falsify the clinical assessment of strength.

**Level of Evidence:** Diagnostic Level I. See Instructions for Authors for a complete description of levels of evidence.

Subacromial injection of local anesthetic is commonly performed to precisely localize the source of pain about the shoulder<sup>1</sup>, to assess strength uninfluenced by pain, and to simulate a potential benefit of a surgical procedure<sup>2</sup>. If shoulder abduction strength remains decreased despite pain relief, structural failure of the rotator cuff and/or suprascapular nerve dysfunction are suspected. If performed without radiographic guidance, however, only 50% to 80% of injections intended to be subacromial have been reported to actually be

strictly subacromial<sup>3-5</sup>, and extrabursal diffusion of local anesthetic has been reported to occur in up to 87%. It is therefore not unlikely that a so-called subacromial injection of local anesthetic might affect the axillary or the suprascapular nerve and thus affect shoulder strength measurements.

The effect of subacromial injection of local anesthetic on shoulder abduction strength is not known. It was the hypothesis of this study that subacromial injection of local anesthetic could decrease shoulder strength in healthy individuals. Verification of

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this hypothesis would imply that subacromial injection could mimic strength loss caused by rotator cuff failure or suprascapular nerve dysfunction, leading to an erroneous clinical diagnosis.

### Material and Methods

Approval of the study was obtained from the responsible ethical committee and the study was registered in the public ISRCTN trial registry (ISRCTN50853594) before initiation. A double-blinded, randomized, placebo-controlled study design was implemented and documented according to the revised CONSORT (Consolidated Standards of Reporting Trials) statement<sup>6</sup>. Healthy eighteen to thirty-five-year-old men who had no history of previous shoulder problems and reported that they had no type of shoulder pain were eligible for inclusion in the study. An a priori sample size calculation indicated that eight volunteers (sixteen shoulders) would be sufficient to identify a treatment-induced difference of 20% in shoulder strength. Two additional volunteers were recruited to compensate for an expected 20% occurrence of extrabursal injections<sup>3,5</sup>. A number was assigned to each participant by one investigator, and another blinded investigator assigned the anesthetic injection to either the left or the right shoulder on the basis of a computerized randomization process. All participants were rescreened on arrival for the trial to ensure that they met the inclusion criteria and gave their informed consent to participate.

Ultrasonography documented the normality of the rotator cuff in each shoulder before proceeding. Electromyographic (EMG) assessment of the deltoid was performed with use of surface electrodes. The primary outcome parameter of this study was shoulder strength, and this was measured prior to the subacromial injection. The subacromial injections were then performed in the right and the left shoulder. Ultrasonography was used to document the exact distribution pattern of the injected liquid, and the pain level was assessed immediately and forty-five minutes after the injection with use of a visual analog scale on which 0 represented no pain and 10 the severest imaginable pain. The EMG assessment was repeated thirty minutes after the injection. Forty-five minutes after the injection, pain was reassessed and the shoulder strength measurements were repeated.

### Measurement of Shoulder Strength

Strength measurements were performed with use of an isometric dynamometer (Isobex; Cursor, Bern, Switzerland)<sup>7</sup>. For the abduction measurements, the patient stood with the arm positioned in 90° of shoulder abduction in the plane

of the scapula. The palm of the hand faced downward and the elbow was fully extended. A strap was applied to the wrist and connected to the dynamometer. The participant was instructed to elevate the arm with maximal force for the abduction strength measurements. The isometric dynamometer calculated the mean of thirty readings over a three-second period of active abduction beginning one second after an abduction strength of 1 kg was exceeded. Three trials were performed in each shoulder, and the mean of the three measurements was recorded as the strength (in N). Subsequently, the shoulder strength was measured with the arm flexed 90° at the shoulder, the palm facing the floor and positioned at the level of the contralateral acromioclavicular joint, and the elbow in full extension ("Whipple test"<sup>8</sup>). Finally, the strength of external rotation was measured isometrically with the same technique used to measure abduction strength, with the volunteer standing, the upper arm at the side, the elbow flexed 90° in 0° of shoulder rotation, and a strap applied at the wrist.

### Subacromial Injection

The intervention consisted of injection of 5 mL of 2% lidocaine hydrochloride (RAPIDOCAINE 2%; Sintetica, Mendrisio, Switzerland) aimed at the subacromial bursa. This represents the protocol for clinical practice at our institution, and the 5-mL volume corresponds to the capacity of the subacromial bursa<sup>9,10</sup>. The placebo control consisted of an identical injection of 5 mL of 0.9% saline solution. All injections were performed by the same orthopaedic surgeon, who was blinded to the content of the two syringes per patient. The patient was positioned in the lateral decubitus position and anatomical landmarks, namely the lateral aspect and anterior and posterior corners of the acromion, were marked. A sterile drape with a small opening was applied, and the shoulder was prepared twice with an alcohol solution. The entry point for the injection was 2 cm lateral to the edge of the acromion, at the palpable interval between the anterior and the lateral fibers of the deltoid muscle. A twenty-gauge needle was inserted and angled 45° anteriorly and 70° relative to the sagittal plane of the scapula (Fig. 1). The fluid was injected when loss of resistance was felt. No radiographic or ultrasonographic guidance was used for needle placement.

### Ultrasonographic Investigations

Prior to the subacromial injections, ultrasonographic examinations of both shoulders were performed according to standard ultrasonography protocols by an experienced musculoskeletal radiologist to exclude abnormal findings<sup>11,12</sup>. All ultrasonographic examinations were performed with use of a high-resolution linear array transducer with a frequency range of 17 to 5 MHz (iU22 ultrasound

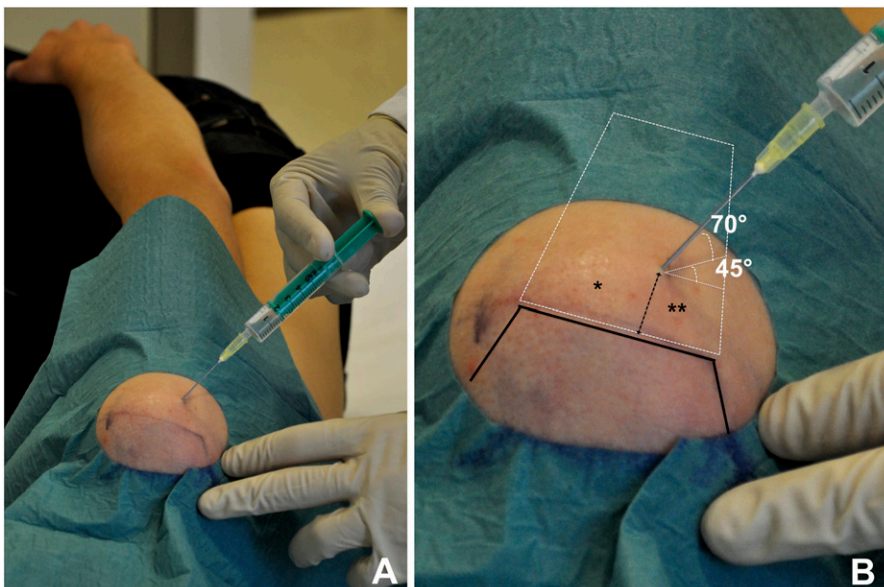


Fig. 1

The subacromial injection is performed with the patient in the lateral decubitus position (Fig. 1-A) with the needle 2 cm lateral to the edge of the acromion, between the anterior (\*) and lateral (\*\*) fibers of the deltoid muscle, and angled 70° to the sagittal plane of the scapula and 45° anteriorly (Fig. 1-B).

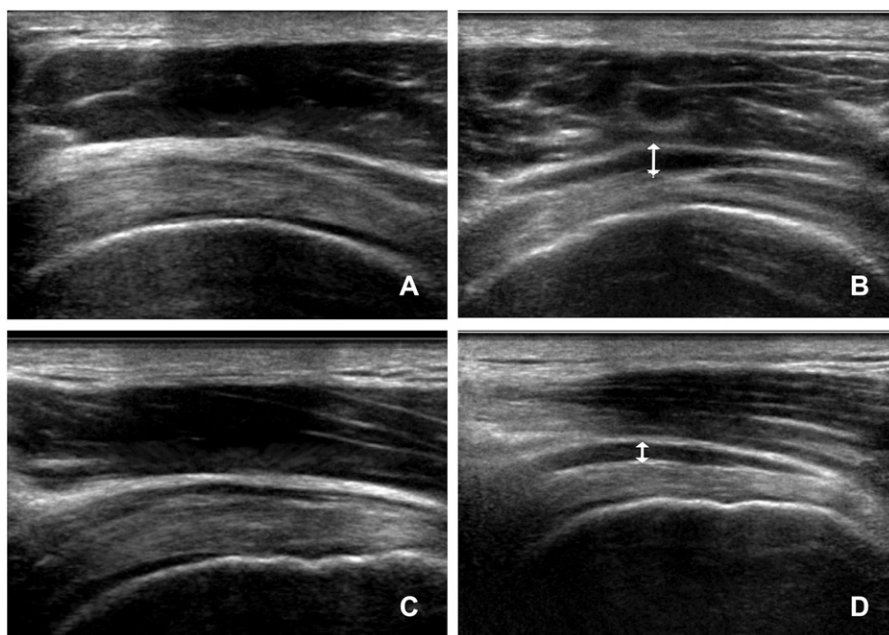


Fig. 2  
Ultrasonographic image of a left shoulder in the sagittal plane (**Figs. 2-A and 2-B**) and the coronal plane (**Figs. 2-C and 2-D**), before (**Figs. 2-A and 2-C**) and after (**Figs. 2-B and 2-D**) injection of the fluid into the subacromial bursa (double-headed arrow).

system; Philips Medical Systems, Best, The Netherlands). The participant was in a sitting position, and all tendons were assessed with the transducer held first in a longitudinal position and then in a transverse position to visualize the tendon.

The ultrasonographic examinations of the shoulders were repeated immediately after the subacromial injections to document the location of the injected fluid according to the following classification (Fig. 2): 0, no fluid detected; 1, fluid in the subacromial bursa; 2, fluid in the subdeltoid bursa; 3, fluid in the deltoid muscle; 4, fluid in the supraspinatus tendon; 5, intra-articular fluid; and 6, subcutaneous fluid. If fluid was detected in more than one of these locations, all locations were recorded separately.

### Electrodiagnostic Investigations

Motor nerve conduction studies of the axillary nerve were performed bilaterally with use of supramaximal constant-current electrical stimulation in the supraclavicular fossa (maximum 100 mA, pulse width 0.2 ms). The compound motor action potential (cMAP) was recorded by means of surface electrodes over the middle section of the deltoid muscle to measure distal latency and amplitude as well as the motor unit number estimate (MUNE) prior to and thirty minutes following the injections. Axillary nerve conduction was selected because the deltoid muscle is readily accessible for semiquantitative testing by means of surface EMG recordings, whereas a similar assessment of the suprascapular nerve and its target muscles (the supraspinatus and infraspinatus) is not feasible because the overlying trapezius muscle would lead to confounding by cross-talk unless needle electromyography was used.

### Statistical Analysis

Sample size calculations indicated that a sample size of eight participants would have 95% power to reveal a 20%<sup>7</sup> difference in shoulder strength, given a standard deviation of 15% and an alpha level of 0.05. Two additional volunteers were included to compensate for potentially imprecise injections. A two-tailed paired Student t test was utilized for intersample and intrasample comparisons. Values are reported as the mean and the standard deviation. A p value of <0.05 was considered significant.

### Source of Funding

No external funding was used for this study.

## Results

### Accuracy of Unguided Subacromial Injection

Two injections in the same study participant were not into the subacromial bursa. The data from the shoulder strength and nerve conduction studies in this participant were not substantially different from those of the other participants but were excluded from further analysis. The other eighteen injections were as desired, resulting in a 90% accuracy of unguided injection. In one of these eighteen shoulders, the fluid escaped from within the bursa and partially entered the deltoid muscle (Fig. 3).

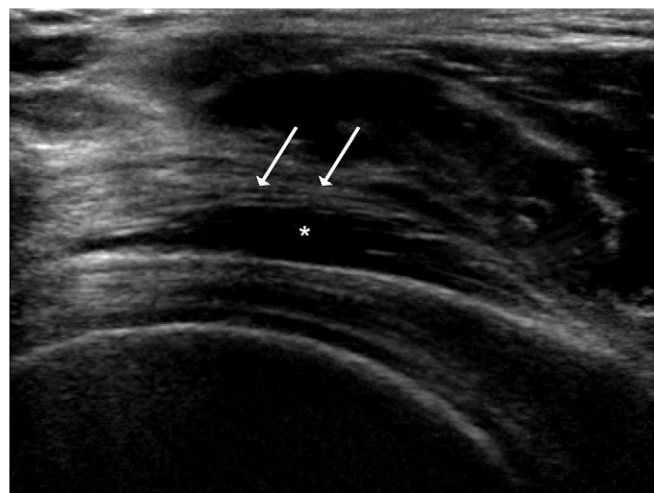


Fig. 3  
Ultrasonographic image of a left shoulder in the coronal plane after injection of the fluid into the subacromial bursa (\*), showing partial extension of the fluid into the deltoid muscle (arrows).



**TABLE I Shoulder Strength Before and After Injection of Local Anesthetic or Placebo**

	Lidocaine*	Placebo*	P Value
Strength in 90° of abduction (N)			
Before injection	87 ± 16	100 ± 14	0.085
45 min after injection	84 ± 8	93 ± 15	0.050
Change	-3 ± 10	-7 ± 13	0.558
P value	0.360	0.165	
Strength in Whipple position (N)			
Before injection	97 ± 15	95 ± 17	0.659
45 min after injection	87 ± 14	84 ± 20	0.589
Change	-10 ± 15	-11 ± 10	0.784
P value	0.092	0.012	

\*Measurements are given as the mean and the standard deviation.

### Shoulder Strength and Pain

A minimal amount of pain was caused by the injection. The pain immediately after the injection was less pronounced ( $0.94 \pm 0.95$ ) in the shoulders that received lidocaine compared with those that received the placebo ( $2.72 \pm 3.11$ ), although the difference did not reach significance ( $p = 0.068$ ). The difference after forty-five minutes was smaller ( $0.78 \pm 1.56$  compared with  $1.44 \pm 1.61$ ,  $p = 0.084$ ).

Shoulder abduction strength was lower in the lidocaine group prior to injection, but the difference did not reach significance. After injection, abduction strength was  $84 \pm 8$  N in the lidocaine group and  $93 \pm 15$  N in the placebo group; the difference reached significance ( $p = 0.050$ ). The change in

abduction strength following the injection was not significant in either group (Table I). Arm elevation strength measured in the Whipple position<sup>8</sup> decreased after injection in both groups, but only the decrease in the placebo group reached significance (Table I). External rotation strength was  $73 \pm 12$  N in the lidocaine group compared with  $79 \pm 15$  N in the placebo group ( $p = 0.05$ ) before injection, and it was  $77 \pm 13$  N compared with  $77 \pm 21$  N ( $p = 0.931$ ) after injection. Neither the change from the pre-injection to the post-injection value in either group nor the difference in the injection-induced change between the two groups was significant.

### Nerve Conduction Studies

Distal latency was similar before injection of lidocaine ( $2.75 \pm 0.60$ ) and placebo ( $2.95 \pm 0.61$  ms,  $p = 0.175$ ) and remained similar after injection ( $2.63 \pm 0.37$  and  $2.92 \pm 0.54$  ms,  $p = 0.186$ ). Likewise, no significant differences were documented for the compound motor action potential amplitude or the motor unit number estimate either prior to or following the injections of lidocaine and placebo (Table II).

### Discussion

Subacromial injection of local anesthetic can eliminate pain in a shoulder with subacromial or rotator cuff pathology, allowing shoulder strength assessment uninfluenced by pain. We performed a randomized, controlled double-blinded study whose results contradicted the hypothesis that such an injection would affect shoulder strength in healthy young adults.

Potential limitations of the study involve the sample size, which was small, and the external validity of the results. First, the effect of subacromial injection of local anesthetic on strength was not investigated in shoulders with rotator cuff tears, as this was not the focus of our research question. However, Park et al. previously reported that abduction strength in shoulders with a full or partial-thickness rotator cuff tear was not significantly affected by injection of a local anesthetic<sup>13</sup>. Second, the sample size could have been larger. An a priori sample size calculation determined the number of participants required to demonstrate a clinically relevant difference. Based on a reported reproducibility of approximately 20% for shoulder strength measurements<sup>7</sup>, we assumed that a strength difference of at least 20% would be of sufficient clinical relevance to change the decision-making process for a treating surgeon. However, sample size calculations are made in anticipation of a certain result, and they depend on a similar distribution of various important patient characteristics between the groups after randomization. If the sample size is small, this similar distribution may not occur, potentially leading to falsely significant differences. This possibility may have been reduced by our study design, in which each test shoulder had a well-matched control, the contralateral shoulder in the same individual. There is evidence indicating that there is no difference between the strength of dominant and nondominant shoulders, and it can therefore be expected that right and left sides can be utilized to provide a valid comparison of shoulder strength<sup>7</sup>. Third, the results lack direct external validity, as subacromial injection of local anesthetic is

**TABLE II Compound Motor Action Potential and Motor Unit Number Estimate Before and After Injection of Local Anesthetic or Placebo**

	Lidocaine*	Placebo*	P Value
Compound motor action potential (mV)			
Before injection	16.0 ± 4.9	15.5 ± 2.8	0.600
30 min after injection	16.1 ± 4.7	16.3 ± 2.5	0.818
Change	0.1 ± 1.3	0.8 ± 1.3	0.307
P value	0.877	0.089	
Motor unit number estimate			
Before injection	99.5 ± 33.3	84.1 ± 23.3	0.270
30 min after injection	93.3 ± 21.8	99.5 ± 30.6	0.489
Change	-6.2 ± 32.4	15.4 ± 40.4	0.153
P value	0.585	0.287	

\*Measurements are given as the mean and the standard deviation.

not typically performed in healthy asymptomatic shoulders but rather in those with shoulder pain and suspected rotator cuff disease. However, if such an injection does not decrease shoulder strength in healthy shoulders, it is reasonable to conclude that it will also not cause decreased strength in patients with rotator cuff disease. Rather, it could be expected to increase strength measurements by eliminating pain as a confounding variable<sup>13</sup>. Our clinical as well as electrodiagnostic findings indicated that there was no impairment of axillary nerve function by subacromial injection of local anesthetic. We did not perform needle electromyography to assess the supraspinatus and infraspinatus. However, previous work has shown that an isolated block of the suprascapular nerve at either the scapular or the spinoglenoid notch leads to a very substantial decrease in external rotation strength as well as abduction strength<sup>14</sup>. The unchanged external rotation strength and abduction strength observed in our study therefore most likely exclude the possibility that the suprascapular nerve was blocked.

Our findings indicate that subacromial injection of a local anesthetic without imaging guidance, as performed in this study,

usually reaches the subacromial bursa, as was the case for 90% of the injections in our study. It had no relevant effect on shoulder strength and did not impair axillary or suprascapular nerve function. It can therefore be used safely to increase the diagnostic accuracy of a physical examination, without concern that the injection of local anesthetic as a part of the testing procedure could introduce another factor affecting shoulder strength. ■

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## References

1. Yu CM, Chen CH, Liu HT, Dai MH, Wang IC, Wang KC. Subacromial injections of corticosteroids and xylocaine for painful subacromial impingement syndrome. *Chang Gung Med J*. 2006 Sep-Oct;29(5):474-9.
2. Oh JH, Kim SH, Kim KH, Oh CH, Gong HS. Modified impingement test can predict the level of pain reduction after rotator cuff repair. *Am J Sports Med*. 2010 Jul;38(7):1383-8. Epub 2010 Jun 3.
3. Mathews PV, Glousman RE. Accuracy of subacromial injection: anterolateral versus posterior approach. *J Shoulder Elbow Surg*. 2005 Mar-Apr;14(2):145-8.
4. Park JY, Siti HT, O KS, Chung KT, Lee JY, Oh JH. Blind subacromial injection from the anterolateral approach: the ballooning sign. *J Shoulder Elbow Surg*. 2010 Oct;19(7):1070-5.
5. Yamakado K. The targeting accuracy of subacromial injection to the shoulder: an arthrographic evaluation. *Arthroscopy*. 2002 Oct;18(8):887-91.
6. Moher D, Schulz KF, Altman DG. The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomised trials. *Lancet*. 2001 Apr 14;357(9263):1191-4.
7. Yian EH, Ramappa AJ, Arneberg O, Gerber C. The Constant score in normal shoulders. *J Shoulder Elbow Surg*. 2005 Mar-Apr;14(2):128-33.
8. Savoie FH 3rd, Field LD, Atchinson S. Anterior superior instability with rotator cuff tearing: SLAC lesion. *Orthop Clin North Am*. 2001 Jul;32(3):457-61, ix.
9. Lie S, Mast WA. Subacromial bursography. *Radiology*. 1982 Aug;144(3):626-30.
10. Strizak AM, Danzig L, Jackson DW, Resnick D, Staple T. Subacromial bursography. An anatomical and clinical study. *J Bone Joint Surg Am*. 1982 Feb;64(2):196-201.
11. Jacobson JA, Lancaster S, Prasad A, van Holsbeeck MT, Craig JG, Kolowich P. Full-thickness and partial-thickness supraspinatus tendon tears: value of US signs in diagnosis. *Radiology*. 2004 Jan;230(1):234-42.
12. Papatheodorou A, Ellinas P, Takis F, Tsanis A, Maris I, Batakis N. US of the shoulder: rotator cuff and non-rotator cuff disorders. *Radiographics*. 2006 Jan-Feb;26(1):e23.
13. Park JY, Lee WS, Lee ST. The strength of the rotator cuff before and after subacromial injection of lidocaine. *J Shoulder Elbow Surg*. 2008 Jan-Feb; 17(1 Suppl):8S-11S.
14. Gerber C, Blumenthal S, Curt A, Werner CM. Effect of selective experimental suprascapular nerve block on abduction and external rotation strength of the shoulder. *J Shoulder Elbow Surg*. 2007 Nov-Dec;16(6):815-20. Epub 2007 Oct 10.